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GROUNDWATER QUALITY ANALYSIS AND ITS IMPACT ON AGRICULTURAL PRODUCTIVITY: A CASE STUDY

P. M. Ghadge[1], D. B. Panaskar[2]

[1, 2] School of Earth Science, Swami Ramanand Teerth Marathwada University, Nanded, India

ABSTRACT

Ground water quality of twenty villages selected were from Karad taluka in Satara district was assessed during pre and post monsoon in the year 2017. The ground water samples were collected from bore wells and open wells, and their quality parameters were assessed for following attributes such as pH values ranges from in pre-monsoon and in post-monsoon, EC values in pre-monsoon and in post-monsoon of the samples. Most of the samples were found to be magnesium dominating in the pre-monsoon and in post-monsoon $Ca2^+$ exceeds the Mg content in most of the water samples. The observation for post monsoon can result in Mg^{2+} toxicity which will be exhibited due to the continuous use this of water to crops.

Cations and anions concentration varies in post-monsoon is Ca-8.251meq/L, Mg^{2+-}11.05 meq/L, CO_{3-}5.275 meq/L, HCO_{3-}10.85, K-21.781, Na^{2+}-8.73 respectively while in pre-monsoon Ca^{2+}-9.625 meq/L, Mg^{2+}-10.248 meq/L, CO3- 2.672meq/L, HCO_{3-} 8.762meq/L, K-13.092meq/L, Na-14.382meq/L respectively.

Some parameters are analyzed statistically such as Mg Hazard, RSC, SSP, KR, RSBC, PI etc.to determine better efficiency of observations. RSC values varied from 1.1-25.2 meq/L in pre-monsoon and 80 % samples are under unsafe while 5 % are in moderate range, 15 % are safe in post-monsoon 1.1- 28.2 meq/L and 85 % are in unsafe, 5 % in moderate,10 % in safe mode, 5 % moderate, 10 % in safe mode for irrigation. SSP values in samples varied from 6.222-79.452 % (post-monsoon) to 6.671-72.84 % (Pre-monsoon); 35 % samples were good while 65 % samples were found unsuitable in pre-monsoon samples and 50 % good while 50 % unsafe in post-monsoon samples respectively.

KR values in pre-monsoon observed 0.0303-6.22 meq/L while in post-monsoon it was 0.143 to 72.631 meq/L; according to Kelley's ratio 75 % in suitable, 5 % marginal and 20 % unsuitable in pre monsoon while 65 % suitable, 5 % marginal, 30 % unsuitable for agriculture. RSBC values are observed in pre-monsoon 1.0-8.65 while in post-monsoon 0.f3-8.65

Permeability Index (PI) also analyzed it was observed in pre-monsoon 14.208-95.661 % in post-monsoon 15.327-71.549 was observed samples are under the categories of 15 % suitable, 55 % good (class II), 30 % unsuitable (class III) in pre-monsoon and 75 % good (class II), 25 % unsuitable (class III). The most of the analyzed water samples are under alkaline category; alkaline water should be managed carefully to avoid negative impacts on crops as well as on soil.

KEYWORDS: Permeability Index, Residual Sodium Carbonate, Residual Sodium Bi-Carbonate, Soluble Sodium Percentage, Magnesium Hazard

INTRODUCTION

Water is the most important factor in the agriculture area. Water resources play a vital role in the development of nation. In India, Maharashtra is a developed state in agriculture and industrialization and most of the industries are agro-based industries. Water is the most important factor in agriculture; different sources are used for irrigation purposes likes as surface water as well as ground water. These sources are polluted from different anthropogenic activities. Mostly ground water is very great source at the time of scarcity of the water i.e.at summer. In the present study area, surface water as well as ground water is available for agriculture purpose. But the major part of the study region covered uses ground water for agriculture; therefore, the present research study focuses on groundwater study for irrigation.

Irrigation practice is the most important tool which affects the yield potential of crop by use of different qualities of irrigation water. Apart from the total concentration of dissolved salts, the concentration of the individual salts, and especially of those of which are most harmful to the crop, is important in determining the suitability of water for irrigation. (Quirk1917). In this research analysis of the different parameters of irrigation water for assessing the actual status of groundwater irrigation problem from different selected sites of Karad taluka. The analysis of water for irrigation should include the cations ($Ca2^{++}$, $Mg2^{++}$ & $Na2^{++}$) and anions (bicarbonates, carbonates, sulfate & chloride) and the anions (bicarbonates, carbonates, sulfate and chloride) Carbonates and bicarbonates ions in the water combine with $Ca2^{++}$ and $Mg2^{++}$ to form compounds that precipitate out of solution. The removal of calcium and magnesium increases the sodium hazards to the soil due to irrigation water.

MATERIAL AND METHODS

In the Satara district 11 numbers of talukas are found, in which Karad taluka is the most important in agriculture sector, where crash crops as well as traditional cropping pattern is found. Karad has situated at the conflict of Krishna and Konya river.

In Karad, rainy, winter and summer these three seasons are found. March, April and mid-May are hottest months while in November, December and January cold temperature and in Mid-June to September rainfall is observed.

Karad is located at 74.181427 longitude and 17.286501 latitude. Twenty villages were selected for the groundwater sample collection, from each site 3 samples were collected. Samples were collected at pre monsoon and post monsoon season; and analyzed immediately in the laboratory for selected parameters. Samples were collected in 2-litter capacity pre-sterilized container. The samples are analyzed by using standard methods of analysis (APHA1999). The calculated values of Magnesium Hazard, RSC, SSP, PI and RSBC, KR where predictable to deliberation for the suitability of ground water quality in the irrigation.

The pH in water sample was determined by using pH meter (Jackson1973). Electrical conductivity (EC) was determined by using conductivity meter (Willard et al, 1974).

Magnesium Hazard

The large amount of magnesium in the water adversely affects soil quality. It converts soil into alkaline in nature thus reducing its crop yield.

Magnesium hazard was calculated as per Raghunath (1987). If the observed value is <50.00 then the water is classified as non-hazard and if the value exceeds 50.00 the water will cause magnesium hazard to the soil.

$$\text{Magnesium Hazard} = \frac{Mg^{2+}}{(Ca^{2+} + Mg^{2+})} \times 100$$

Soluble Sodium Percentage (SSP)

Soluble sodium percent (SSP) was classified as per Wilcox (1955) category

$$\text{Soluble sodium percent} = \frac{Na^{+} + K^{+}}{Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}} \times 100$$

Where Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} are concentrations of respective ions in meq/l.

Residual Sodium Carbonate

Residual sodium carbonate (RSC) has been calculated to determine the hazardous effect of carbonate and bicarbonates on the quality of water for agricultural purpose and is expressed by the equation where all ionic concentration are expressed in meq/l (Eaton 1950).

In water having high concentration of bicarbonates, there is tendency for Ca2+ and Mg2+ to precipitate as a carbonate. (Elton 1950).

The Residual sodium carbonate (RSC) is calculated using enlisted formula;

RSC= (Co3+ HCo3)- (Ca+ Mg)

Gives results and rating of waters based on RSC (WHO 1989)

Sr.no	RSC (meq/l)	Irrigation class	No. of samples class	
			Pre monsoon	Post monsoon
1	<1.25	Safe	03	02
2	1.25 -2.50	Marginal	1	03
3	>2.50	Unsuitable	16	15

Table No.:1 Observations for samples analyzed for Pre-monsoon and post monsoon period to determine Residual sodium carbonate (RSC)

Kelley's Ratio (KR):

Suitability of water for irrigation purpose is expressed on the basis of Kelly's ratio (Kelly1951). Ground-water having Kelly's ratio more than one is considered as not-suitable for irrigation purposes.

Kelley's Ratio (KR) = $Na^{+}/Ca^{2+} + Mg^{2+}$

All cations are expressed in meq/l

Kelley's Ratio	Irrigation sample	No of Samples	Frequency (%)
>1	Suitable	15	75
1-2	Marginal suitable	01	5
>2	Unsuitable	04	20

Table No.:2(a) Observations for samples analyzed for Pre-monsoon period to determine Kelley's Ratio (KR).

Kelley's Ratio	Irrigation sample	No. of samples	Frequency(%)
>1	Suitable	13	65
1-2	Marginal suitable	01	5
>2	Unsuitable	06	30

Table No.:2(b) Observations for samples analyzed for Pre-monsoon period to determine Kelley's Ratio (KR).

Residual Sodium Bi-carbonates

Gupta and Gupta (1987) classified water on the basis of Residual Sodium Bi-carbonates (RSBC).

RSBC= HCO_3 - Ca

The calculated values of RSBC for estimated samples for pre-monsoon and post-monsoon period are shows in table no.-

Sr.no.	RSBC	Category	No. of samples	Frequency (%)
1	<5	Satisfactory	12	60
2	5-10	Marginal	07	35
3	>10	Unsatisfactory	01	5

Table No.:3 (a) Observations for samples analyzed for Pre-monsoon period to determine Residual Sodium Bi-carbonates (RSBC)

Sr.no.	RSBC	Category	No. of samples	Frequency (%)
1	<5	Satisfactory	16	80
2	5-10	Marginal	04	20
3	>10	Unsatisfactory	00	00

Table No.:3 (b) Observations for samples analyzed for post-monsoon period to determine Residual Sodium Bi-carbonates (RSBC)

Permeability Index

The soil permeability is affected by long term use of irrigation water. Sodium, Calcium, Magnesium and bicarbonate content of soil influence it. Doneen, evolved a criterion for assessing the suitability of water for irrigation based on the permeability index (PI). The permeability index for water samples for pre monsoon and post monsoon period was estimated and classification of irrigation water quality was done based on the respective observations of the Permeability Index (PI) as enlisted in below table.

Sr.no	PI in (%)	Category	No. of samples	Frequency (%)
1	>75	Class I (suitable	03	15
2	25-75	Class II (Good)	11	55
3	<25	Class III (Unsuitable	06	30

Table No.:4(a) Observations for samples analyzed for Pre-monsoon period to determine permeability index (PI).

Sr.no	PI in (%)	Category	No. of samples	Frequency (%)
1	>75	Class- I (suitable	00	00
2	25-75	Class- II (Good)	15	75
3	<25	Class-III (Unsuitable)	05	25

Table No.:4 (b) Observations for samples analyzed for post-monsoon period to determine permeability index (PI).

RESULT AND DISCUSSION

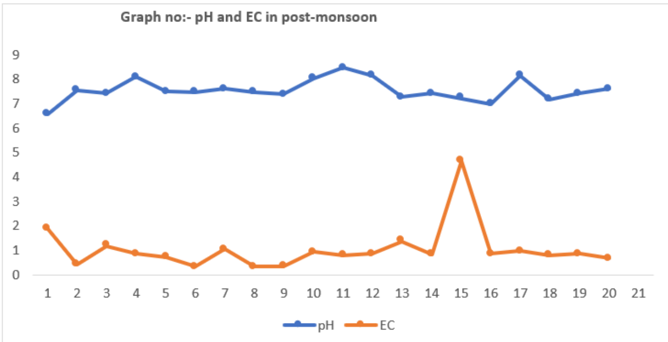
pH and Electrical conductivity (EC)

In the present study samples were analyzed for different parameters. For the collected samples pH was found in range of 6.88 to 8.27 which is comparatively higher than pre-monsoon. This may be due to dilution of water as a result of precipitation.

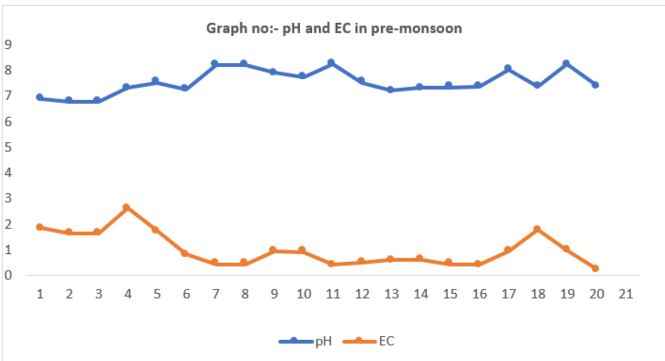
Electrical Conductivity in pre- monsoon maximum and post-monsoon minimum value observed due to increased rate of evaporation leading to high concentration of salts and dilution resulting from precipitation respective. (Iqbal S A and Kataria H.C.1995).

Sr. No.	Sample	Post-monsoon pH	Post-monsoon EC (ds/m)	Pre-monsoon pH	Pre-monsoon EC (ds/m)
1	GS1	6.87	1.838	6.56	1.896
2	GS2	6.79	1.641	7.52	0.414
3	GS3	6.79	1.641	7.41	1.187
4	GS4	7.32	2.623	8.10	0.862
5	GS5	7.52	1.732	7.49	0.732
6	GS6	7.24	0.833	7.46	0.333
7	GS7	8.21	0.435	7.60	1.063
8	GS8	8.21	0.435	7.46	0.334
9	GS9	7.90	0.918	7.37	0.359
10	GS10	7.73	0.899	8.03	0.942
11	GS11	8.25	0.416	8.47	0.798
12	GS12	7.52	0.502	8. 12	0.882
13	GS13	7,21	0.590	7.26	0.879
14	GS14	7.32	0.605	7.44	1.372
15	GS15	7.34	0.431	7.21	0.382
16	GS16	7.37	0.411	6.98	4.672
17	GS17	8.02	0.951	8.12	0.881
18	GS18	7.35	1.779	7.17	0.973
19	GS19	8.23	0.986	7.41	0.817
20	GS20	7.39	0.227	7.61	0.687
Minimum		6.88	0.22	6.56	0.333
Maximum		8.27	2.623	8.15	4.682

Table No.:5 Average concentration of EC and pH of selected sites for ground water samples in post- monsoon and post-monsoon used for irrigation.



Graph no: 1 Observations of pH and EC in pre-monsoon.



Graph No. 2 Observations of pH and EC in post-Monsoon

Cations and Anions

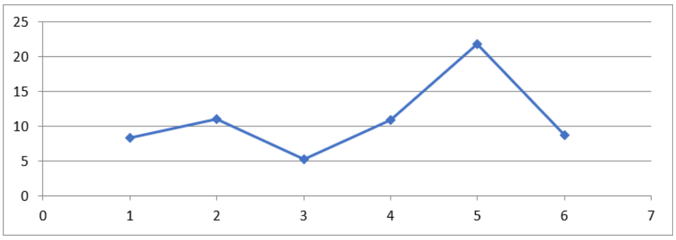
The water samples were analyzed for cations like Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and anions like CO^{3-} and HCO_3--, results are shown in the table no.6a (post-monsoon) and table no. 6b (pre-monsoon)

The dissolved ionic species in the groundwater are the resultant product of weathering of rock forming minerals with minor contribution form precipitation and anthropogenic activities (Berner and Berner 1987). Farmers use chemical fertilizers in the agriculture for high yield profit which allows in increasing the concentration of cations and anions in the groundwater through the percolation of water. The table no. 6a (post-monsoon) shows the result of calcium content range from 0.15 to20.5and magnesium content range from 2.4.to 31.4 and 0.15 to18.5 of Ca and 0.5 to 27.5 in the pre monsoon (table no. 6b). Most of the samples result shows calcium dominates over magnesium ions; while in some cases magnesium ions are dominated. If the proportion of magnesium cations is higher then, the sodicity hazard is higher, and contraversively, if calcium predominates, the hazard is low. Magnesium is known to affect plant growth mainly reducing calcium uptake and causing calcium deficiency. If water used for irrigation is high in sodium and low in calcium, the cation exchange complex may become saturated with sodium. This can destroy the soil structure owing to dispersion of the clay particles. (Meri and Shalhavet, 1979).

Carbonate and bicarbonate ions combined with Ca^{2+} and Mg^{2+} precipitate as $CaCO_3$ or $MgCO_3$ which concentrates in drying conditions. The concentration of calcium and magnesium decreases relative to sodium and SAR index will be bigger. This will cause an alkalizing effect and increases the pH. Therefore, when a water analysis indicates high pH level, it may be a sign of high content of carbonates and bicarbonates ions.

Sr.no.	Cat-ions & Anions	Ca^{2+}	Mg^{2+}	CO_3^-	HCO_3^-	K^+	Na^+
1	Mini-mum	0.15-4.7	2.4-4.3	0.8-2.4	6.03-6.42	0.792-1.37	0.86-4.32
2	Maxi-mum	5.3-20.5	8.8-31.4	3.2-4.08	8.4-14.07	25.04-54.11	8.17-42.10
3	Mean	8.2511	11.05	5.275	10.85	21.781	8.73

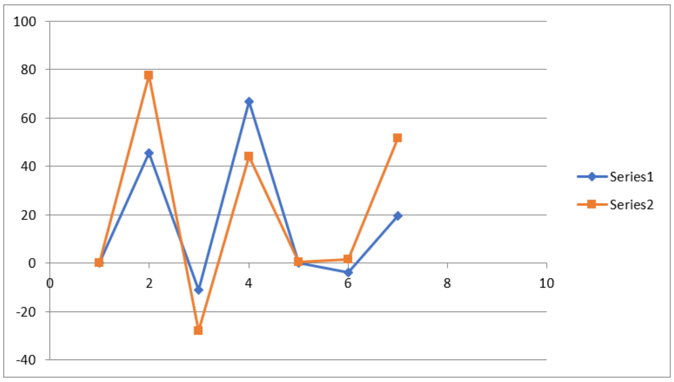
Table no.: 6 (a) Observations of Cations and Anions from Sample Sites for Post-monsoon Period.



Graph No:3 Graphical Representation of Observations of Cations and Anions From Sample Sites for Post-monsoon Period.

Sr. no.	Cations & An-ions	Ca^{2+}	Mg^{2+}	CO_3^-	HCO_3^-	K^+	Na^+	Cl^-
1	Mini-mum	0.15-7.2	0.5-2.0	0.8-1.6	4.5-5.2	0.311-1.45	0.1304-3.3	0.8-1.6
2	Maxi-mum	12.5-18.5	29.9-27.5	7.2-4.8	12.4-11.60	38.20-45.00	11.04-13.77	2.8-16.00
3	Mean	9.6725	10.2485	2.672	8.762	13.0921	14.3828	

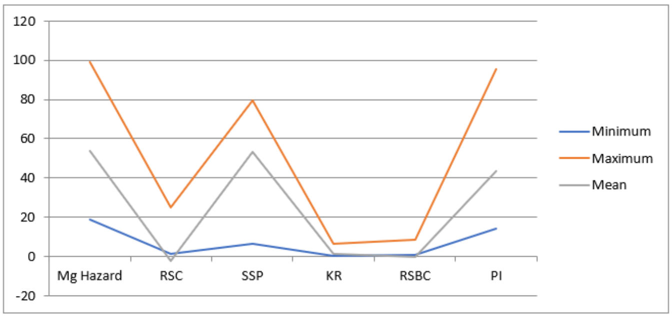
Table no.:6 (b) Observations of Cations and Anions from Sample Sites for Pre-monsoon Period.



Graph No:4 Graphical Representation of Observations of Cations and Anions from Sample Sites for Pre-monsoon Period.

Sr.no.	Sample	Mg Hazard	RSC	SSP	KR	RSBC	PI
1	GS1	71.04	-25.6	37.29	0.556	-2.4	14.208
2	GS2	33.51	-4.4	70.82	0.3388	-0.5	34.146
3	GS3	99.299	-11.8	74.78	2.522	8.65	45.143
4	GS4	45.631	-11	66.84	0.2572	-4	19.545
5	GS5	77.75	-28.1	43.94	0.3854	1.6	51.55
6	GS6	44.211	-1.1	78.885	0.5178	1	36.193
7	GS7	46.808	4,8	32.904	0.467	1	48.832
8	GS8	44.211	0.9	78.869	0.475	1	48.832
9	GS9	22.22	2	75.992	0.172	0.4	42.389
10	GS10	90.59	-0.33	75.308	0.3423	6.65	46.169
11	GS11	90.625	-10.40	47.5	0.875	-2.10	54.666
12	GS12	18.908	-5.20	6.222	6.222	-5.60	21.712
13	GS13	27.77	-3.20	29.674	0.328	-2.90	45.355
14	GS14	75.00	-7.30	73.023	0.0881	5.05	25.388
15	GS15	37.50	-8.40	73.236	2.3913	-3.10	77.24
16	GS16	49.257	24.00	53.391	0.6905	-6.50	17.893
17	GS17	18.19	-5.20	5.9055	0.173	-5.60	21.707
18	GS18	50.00	11.50	79.452	3.39	4.80	95.661
19	GS19	81.923	14.80	14.423	0.0303	5.70	22.335
20	GS20	48.75	25.20	50.186	1.00	-10.10	98.92
Minimum		18.91	1.10	6.222	0.0303	1.00	14.208
Maximum		99.299	25.20	79.452	6.222	8.65	95.661
Mean		53.66	-2.182	53.432	1.0611	-0.348	43.394

Table No.:7 (a) Observations of Selected Derived Parameters of Groundwater Quality.



Graph No.:5 Observations of Selected Derived Parameters of Groundwater Quality.

Sr. No.	Sample	Mg Hazard	RSC	SSP	KR	RSBC	PI
1	GS1	56.76	-12.60	25.89	0.309	1.10	41.401
2	GS2	33.50	-4.40	70.82	0.0338	1.50	34.019
3	GS3	99.20	-11.80	50.00	44.81	8.67	45.143
4	GS4	68.70	-25.60	27.40	34.42	0.50	36.815
5	GS5	72.57	28.20	13.515	0.252	1.10	17.136
6	GS6	21.77	-3.20	29.75	32.82	-2.90	45.355
7	GS7	4.6	-5.20	72.84	0.264	-7.00	22.368
8	GS8	55.38	-12.80	63.84	1.737	1.00	71.549
9	GS9	43.60	-4.60	36.08	0.495	-0.75	55.18
10	GS10	29.26	-19.8	52.165	0.329	2.01	51.278
11	GS11	47.36	-8.40	44.66	72.631	-2.80	52.041
12	GS12	26.79	1.10	71.531	0.289	0.40	39.655
13	GS13	21.52	1.10	67.636	6.027	-6.20	22.131
14	GS14	43.25	-16.60	58.60	0.353	-6.50	21.192
15	GS15	4.166	1.70	23.141	0.425	-3.50	47.712
16	GS16	36.4	-8.20	63.44	36.410	-4.40	37.59
17	GS17	30.40	-19.0	29.58	35.27	-2.25	46.053
18	GS18	64.00	3.65	58.36	0.178	-0.70	37.413
19	GS19	40.25	4.85	10.44	0.189	0.23	31.224
20	GS20	28.71	-2.70	6.671	0.143	-2.70	15.327
Minimum		4.166	1.10	6.671	0.143	0.23	15.327
Maximum		99.20	28.20	72.84	72.631	8.65	71.549
Mean		41.379	9.088	43.785	11.72	-14.31	38.50

RSC & RSBC

Sr.no	RSC Values	RSBC	Category	No. of Samples (RSC)	No. of Samples (RSBC)
1	<1.25	<5	Safe	03	11
2	1.25-2.50	5-10	Moderate	05	08
3	>2.50	>10	Unsuitable	15	01

Table no.:8 (a) Observations of Analysis of Groundwater Quality of Selected Sample Sites for RSC & RSBC. (Pre-Monsoon samples)

	RSC Values	RSBC	Category	No. of Samples (RSC)	No. of Samples (RSBC)
1	<1.25	<5	Safe	02	08
2	1.25-2.50	5-10	Moderate	03	03
3	>2.50	>10	Unsuitable	15	09

Table no.:8 (b) Observations of Analysis of Groundwater Quality of Selected Sample Sites for RSC & RSBC. (Pre-Monsoon samples)

RSC values varied from1.1to 8.4 in the post-monsoon (Table no7b.) while 1.1 to 25.2 in the pre- monsoon (Table no.7a). RSC values for 03 samples are found under safe, 05 are moderate while 15 under unsuitable.

RSBC values are also varied from 1.0 to 8.65 in the pre-monsoon and from 0.23 to 8.67 in the pre monsoon. A high range of RSC value in irrigation water means an increase in the adsorption of sodium in the soil. The negative values of RSC indicate that concentration of Ca2+ and Mg2+is in excess. A positive value of RSC denotes that Na+ existence in the soil is possible. RSBC indicates excess concentration of HCO3- over Ca2+ (Hussain and Hussain 2004). The negative values of RSBC in the study area shows excess HCO3+ in irrigation water.

Soluble sodium Percent (SSP)

Soluble sodium percent (SSP) helps to estimate whether the quality of water is suitable for irrigation. The soluble sodium percent (SSP) was estimated for the 60 samples from the selected sample sites.

Soluble sodium percent was worked out and it ranged from 43.785 to72.84 in post-monsoon (table no.7b) and 6.222 to 79.452 (table no.7a) in pre-monsoon are shown in below the table no.09.

Sr.no.	RSC Values	SSP Values meq/l	Water classification	No. of Samples (pre-monsoon)	No. of samples (post-monsoon)
1	<50	Good	07	10	08
2	>50	Unsuitable	13	10	03

Table no.:9 Observations of Analysis of Groundwater Quality of Selected Sample Sites for SSP Values. (Pre-monsoon and Post-monsoon samples)

CONCLUSION

In the present research study, we have analyzed almost 60 samples (from each site of 3 samples) from different locations in pre-monsoon and post-monsoon period. From collected samples pH, was found higher in the pre-monsoon. This may be found due to dilution of water as a result of precipitation. EC in pre-monsoon was maximum and in post-monsoon minimum values observed i. e. value indicates salt concentration. Cations and anions concentration are also important for the irrigation. In present samples results shows calcium dominated in some causes. In cause of magnesium ion dominated there is chance to produce sodicity hazard recipes and forms respective carbonates ions which concentrate in drying conditions, resulted into increase in pH level in water, which is best indication of high content of carbonates and bicarbonates ions. RSC values varied in both monsoons, in pre-monsoon15% of samples under safe 5% samples are moderate while 80% under unsafe while

in post-monsoon it shows 10% safe, 5% moderate and 85% unsafe for irrigation. SSP values observed in pre-monsoon 35 % good, 65% are unsuitable while in post-monsoon 50 % good and 50 % are unsuitable for irrigation. Permeability index (PI) for analyzed samples in pre-monsoon15% are suitable (class I), 55% good (Class II), and 30% are under unsuitable (Class III) was found in pre-monsoon while 75% good (class II) and 25% unsuitable (Class III) was found.

Result variations are found due to the geographical conditions and climatically reasons i.e., due to the evaporation of water, lowering of water tables as atmosphere increasing in the summer before monsoon. As well as excess use of fertilizers in the field for higher production. There is need of proper management of irrigation systems to avoid the over irrigation as well as to keep soil safe of agriculture in feature.

REFERENCES

1. Health Hazards from Nitrate drinking water Report on a WHO meeting Copenhagen 5-9 march, 1989
2. A assessment of Ground water Quality for Irrigation in Farms Horticulture College
3. APHA, (1998),Standard methods for examination of water and wastewater,19thedn. American Public Health Association, Washington, DC, (1995) BIS:11624
4. Guidelines for quality of irrigation water, Bureau of Indian Standards, New Delhi,
5. Burner, E.K.and Burner, R.A.,(1987),
6. The global water cycle: Geochemistry and Environment. Prentic-Hall, Englewood cliff. Elton,F.M.,(1950),
7. Significance of carbonate in irrigation water, Soil science,69(2),Pp123-133.
8. Kelly W.p.,(1951),Alkali soils-Their formation properties and reclamation.3rd edition. Reinhold Publication, New York, USA,p92.
9. Ragunath, H.M.,(!987), Groundwater, Wiley Eastern Ltd. New Delhi, p563
10. WHO (1989), Health guidelines for the use of waste water in agriculture and
11. Aquaculture. Report of a WHO scientific Group-Technical report series, 778,
12. WHO Geneva,p74.Todd D K (1980) Groundwater hydrology, second Edn.Wiley, New York, p535
13. Mohsen Seilsepour, Majid Rashidi,(2008),Modeling of Soil Sodium Adsorption Ratio Based on Soil Electrical Conductivity, APRN Journal of Agricultural and Biological Science vol.03,no.586, Sept.2008 pp-27-31.